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AN ECONOMETRIC MODEL FOR PREDICTING WATER-ORIENTED OUTDOOR RECREATION DEMAND

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PREFACE

This report is the second of a series developed from research conducted under a cooperative agreement with the University of Missouri. It is part of a continuing program of the Economic Research Service in outdoor recreation research. The model developed here is designed for use in estimating the demand of a metropolitan area for water-oriented outdoor recreation. The Department of Agriculture, other governmental units, and private developers may utilize the model in their planning of natural resource development for outdoor recreation activity.

The survey of 1,000 families in St. Louis, Mo., which is analyzed in the report, was made in 1964. The results were tabulated and brought together in 1966 in unpublished form. In the meantime, one of the authors was transferred to other duties outside the State, so publication was unavoidably delayed. However, data of the type collected in the survey are relatively stable--compared with prices, for example--and the conclusions are still valid.

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Washington, D.C. 20250 March 1969

SUMMARY

Land-use planners and investors can now make better estimates of the demand for water-oriented recreation facilities in specific areas.

The estimates are made by using an econometric model developed in cooperative USDA-State research. The model, one of the first of its kind, analyzes socioeconomic characteristics associated with water-oriented outdoor recreation activities of people: annual family income, education, sex, race, age, and occupation.

The model, applied to a 1,000-family sample of people in the St. Louis, Mo., area indicated that they would have averaged 27.3 days of water-oriented recreation a year. Interviews revealed that the families spent 27.0 days, showing how closely the estimate followed the known data.

Future demand can be estimated, with acceptable accuracy, through use of the model with data from census reports, much in the same way as the test was done. If certain socioeconomic characteristics of the population are expected to change over time, allowances can be made to estimate resulting changes in recreation demand. As a family moves up the income scale, a corresponding increase in recreation activity is expected. As education levels increase, recreation demand will increase.

Because the methodology is based on a sample survey of only one metropolitan population in one time period, the appropriateness of using the model in other metropolitan areas must be carefully assessed. Other areas may have radically different characteristics, especially the available supply of outdoor recreation facilities. The coefficients (socioeconomic characteristics) should also be reassessed for changes which may occur over time.

AN ECONOMETRIC MODEL FOR PREDICTING WATER-ORIENTED OUTDOOR RECREATION DEMAND

by

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INTRODUCTION

As population increases and competitive pressures mount for land, preservation and development of areas for recreation by present and future generations has become a major national problem. Reliable estimates of the recreation demands of various segments of the population are of primary importance in determining the types of land and water resource developments to be undertaken by State and Federal Governments as well as by private developers.

The importance of recreational development, particularly in marginal rural areas, is pointed out in the following statement:

> Although the chief reason for providing outdoor recreation is the broad social and individual benefits it produces, it also brings about desirable economic effects. Its provision enhances community values by creating a better place to live and increasing land value. In some underdeveloped areas, it can be the mainstay of the local economy. And it is a basis for big business as the millions and millions of people seeking the outdoors generate an estimated $20 billion a year market for goods and services. 1/

Water-oriented outdoor recreation includes a wide range of activities. Any recreation pursuit that requires or is enhanced by the use of water in an outdoor setting can be classified as water-oriented outdoor recreation. Better estimates of demand for various types of water-oriented outdoor recreation are needed if planners and managers of recreation areas are to provide those facilities and services desired by recreationists.

1/ Outdoor Recreation Resources Review Commission. Outdoor Recreation for America. p. 4. Washington, D.C. Jan. 1962.

Purpose of the Study

At present, the U.S. Department of Agriculture is actively engaged in planning and operating programs and projects concerning the development, conservation, and preservation of land and water resources. Many of these programs and projects include recreation use by the public.

The recreation policy of USDA is to provide the research, technical, educational, and financial help needed to strengthen existing programs of recreation development. In USDA's river basin and watershed studies, determination of annual visits in recreation days is necessary for economic feasibility analysis of water development projects and in planning water-associated recreation areas.

Previous studies made at various recreation sites do not provide the data needed for determining the demand for a metropolitan population for water-oriented outdoor recreation. The purpose here was to assemble demand data by direct sampling of a metropolitan population. The demand for water-oriented outdoor recreation was estimated by using covariance analysis and beta coefficients for each significant socioeconomic factor, both quantitative and qualitative.

An econometric model was developed to assess the socioeconomic characteristics influencing the demand for water-oriented outdoor recreation. The objective was to identify the significant factors that affected the demand for water-oriented outdoor recreation facilities in the St. Louis, Mo., area and to estimate their respective influences. Variance and covariance analyses were used to determine the significance of relationships. The sampling procedure is presented in the appendix.

The Sample Area

The sample area consisted of St. Louis (City) and St. Louis County. So that the model may be more fully assessed for use in other areas, a brief description is given of the available outdoor recreation opportunities in the vicinity of St. Louis.

There are approximately 150 lakes, both private and public, ranging from 5 to 400 surface acres, within a 50-mile radius of the metropolitan center. Within this area, there are also numerous lakes of less than 5 acres, many undeveloped. Within 1 to 2 hours' highway travel time, there are 10 lakes in the Ozarks that offer a total array of water-oriented recreation activities. Lake of the Ozarks, comprising more than 59,000 acres, is one of the most highly developed lakes in the region, with most of the adjoining shoreland owned and developed by private individuals. Also within less than 150 miles there are 16 well-developed State parks, two national forests (Clark and Mark Twain), hundreds of miles of natural streams and river shoreline, numerous commercial caves, campgrounds, hunting lodges, summer camps, resort motels, riding stables, canoeing access points, springs, and commercial playgrounds.

ANALYSIS OF THE SOCIOECONOMIC FACTORS

The variables considered in analyzing the water-oriented outdoor recreation demand of the St. Louis area population are listed in table 1. All of the variables listed were assumed to have a significant influence on the demand for water-oriented outdoor recreation. For this reason, all variables were considered in the first phase of the analysis. Using the "t" test for the b value of each variable, the variables not found to be significant were dropped and an additional computer run was made considering only the significant socioeconomic characteristics. Each characteristic was tested again for significance using the "F" test. The following formula was used:

$$F = \frac{(S_{\omega} - S_{\nu})/(d.f._{m} - d.f._{n})}{S_{\nu}/d.f._{n}}$$

where:

S_{ω} = Sum of squared residuals in the restricted model
S_{ν} = Sum of squared residuals in the general model
m = Degrees of freedom for S_{ω}
n = Degrees of freedom for S_{ν}.

The factors found to be significant were: annual family income, education, sex, race, age, and occupation. Age and education were significant when entered as quadratics. Family income and age were significant as cross-products. The degree of influence of each factor upon demand for water-oriented outdoor recreation is indicated in the general econometric model presented. Covariance analysis was used to isolate the influence of each specific factor or characteristic on the demand for this type of recreation.

In the analysis, zero-one values were assigned to some of the variables. This method of handling the data was especially helpful in estimating the effect of the qualitative variables such as sex, race, marital status, and occupation upon the demand for water-oriented outdoor recreation. The procedure was adapted from the work of Johnson. 2/

Zero-one or dummy variables are especially useful in regression analysis to estimate specific class effects of qualitative variables. The zero-one methodology requires one restriction for each of the factors to have the number of linearly independent equations equal to the number of unknowns in the least squares estimation procedure. The usual procedure is to set one of the parameters equal to zero, as the additional equation, to give this restriction and allow a solution to be reached.

2/ J. Johnson Econometric Methods. p. 221. New York: McGraw-Hill Book Company, Inc. 1963.

Table 1.--Variables used in analyses of the water-oriented outdoor recreational activities, St. Louis, Mo., metropolitan population

Number	Variable 1/
X_1 ---	Annual recreation days per family 2/
X_2 ---	Annual family income
X_3 ---	Leisure time
X_4 ---	Education
X_5 ---	Sex
X_6 ---	Race
X_7 ---	Age
X_8 ---	Leisure time--squared
X_9 ---	Occupation--professional
X_{10}---	Occupation--administrator
X_{11}---	Occupation--technical
X_{12}---	Occupation--services
X_{13}---	Occupation--clerical
X_{14}---	Occupation--laborer
X_{15}---	Occupation--housewife
X_{16}---	Occupation--unemployed
X_{17}---	Household head--husband only
X_{18}---	Household head--husband and wife
X_{19}---	Household head--husband and wife and others
X_{20}---	Household head--wife only
X_{21}---	Household head--other than husband and wife
X_{22}---	Household head--husband and others
X_{23}---	Childhood home--farm
X_{24}---	Childhood home--rural nonfarm
X_{25}---	Childhood home--city under 10,000
X_{26}---	Childhood home--city 10,000-99,999
X_{27}---	Childhood home--city 100,000+
X_{28}---	Family income--squared
X_{29}---	Age--squared
X_{30}---	Education--squared
X_{31}---	Family income x leisure time
X_{32}---	Family income x age
X_{33}---	Leisure time x age

1/ Variables X_3 to X_{27} refer to specific characteristics of the household head only.

2/ Recreation days in this analysis refer to water-oriented outdoor recreation. A recreation day is a standard unit of use consisting of a visit by one individual to an outdoor recreation development or area for recreation purposes during any portion or all of a 24-hour period measured from midnight.

The items entering the model as dummy variables in the final analysis, with their corresponding base variables met at zero, were:

X_5 - Sex Male = 0
Female = 1
X_6 - Race White = 0
Nonwhite = 1
X_9 through X_{16} - Occupation.

The occupation of the household head was entered as 1; all other occupational categories were entered as zero. The retired category was entered as zero, providing the base for comparison with the other occupations.

The other b values associated with the zero-one variables indicated the deviations of the other class intercepts from this base. If the model is used to estimate the annual water-oriented outdoor recreation days for a family in which the head of the household is retired, it would enter as zero for occupation, X_9 through X_{16} would drop out and no specific b value would be used in the equation. The effect of the retired class appears in the constant term. The values of male and white are also included in the constant term.

Specification of the Model

The **hypothesis** that the dependent variable, annual water-oriented outdoor recreation days, is a function of the specific effects of the various independent variables may be written: 3/

$$X^{(1)}_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + \delta_2 X_2 + \delta_3 X_3 + --- \delta_n X_n + \varepsilon_{ijk}$$

where:

$X^{(1)}_{ijk}$ = Annual water-oriented outdoor recreation days
μ = mean intercept value as determined from the zero-one variables
α_i = net effect of sex
β_j = net effect of race
γ_k = net effect of occupation
δ = coefficient of the continuous variables
ε_{ijk} = random component with expectation zero and constant variance from observation to observation.
i varies from 1 to 2 - male--female
j varies from 1 to 2 - white--nonwhite
k varies from 1 to 9 - occupation.

3/ The authors wish to acknowledge assistance during formulation of the econometric model by Professor Oscar R. Burt while he was on the staff of the University of Missouri.

If $\mu_{ij} = \mu + \alpha_i + \beta_j$, then the model can be written:

$$X^{(1)}_{ijk} = \mu_{ij} + \gamma_k + \delta_2 X_2 + --- \delta_n X_n + \varepsilon_{ijk}.$$

Using the b values for sex and race, the μ_{ij} may be estimated. That is, by adjusting the intercept value, the effect of α_i and β_j will be reflected in the intercept.

This may be shown in the following table of the estimates of μ_{ij}:

j i	1	2
1	$\hat{\mu}_{11}$	$\hat{\mu}_{12}$
2	$\hat{\mu}_{21}$	$\hat{\mu}_{22}$

where:

i_1 = male
i_2 = female
j_1 = white
j_2 = nonwhite
$\hat{\mu}_{11}$ = mean intercept for male-white
$\hat{\mu}_{12}$ = mean intercept for male-nonwhite
$\hat{\mu}_{21}$ = mean intercept for female-white
$\hat{\mu}_{22}$ = mean intercept for female-nonwhite.

In this way, the intercept can be computed for any specific combination of sex and race.

A further expansion can be made to include the occupation variable, X_9 through X_{16}. The same method would be used to adjust the intercept value for any specific set of socioeconomic characteristics using the zero-one technique. Thus the zero-one variable values are reflected in the intercept, the other variables in the slope of the regression line.

Empirical Model

Inserting the coefficients for the significant socioeconomic characteristics results in the following model:

$$
\begin{aligned}
X_1 = 66.937580 &+ \underset{(.001)}{-.001540}\, X_2 + \underset{(1.75)}{-4.170880}\, X_4 + \underset{(4.64)}{-5.859799}\, X_5 \; + \\
&\underset{(4.56)}{-14.272207}\, X_6 + \underset{(.06)}{-.076362}\, X_7 + \underset{(7.03)}{-21.310164}\, X_9 + \underset{(6.41)}{-20.643547}\, X_{10} \; + \\
&\underset{(6.82)}{-12.492111}\, X_{11} + \underset{(5.78)}{-13.996154}\, X_{12} + \underset{(7.05)}{-20.866292}\, X_{13} + \underset{(6.07)}{-6.898131}\, X_{14} \; + \\
&\underset{(7.41)}{-6.544165}\, X_{15} + \underset{(12.99)}{-18.104001}\, X_{16} + \underset{(.006)}{-.007790}\, X_{29} + \underset{(.0745)}{.218604}\, X_{30} \; + \\
&\underset{(.000018)}{.000068}\, X_{32} \qquad R^2 = 0.62.
\end{aligned}
$$

Values in parentheses are the standard errors for each b value; where:

B_0 = constant term
X_1 = dependent variable--annual water-oriented outdoor recreation days per family
X_2 = annual family income
X_4 = education of household head
X_{5*} = sex of household head
X_{6*} = race of household head
X_7 = age of household head
X_{9*} = occupation--professional
X_{10*} = occupation--administrative
X_{11*} = occupation--technical
X_{12*} = occupation--services
X_{13*} = occupation--clerical
X_{14*} = occupation--laborer
X_{15*} = occupation--housewife
X_{16*} = occupation--unemployed
X_{29} = age--squared
X_{30} = education--squared
X_{32} = family income x age

*Entered as zero-one, or dummy variables.

INTERPRETING THE ZERO-ONE VARIABLES

Zero-one variables may be used for two purposes: to estimate the total class effects of qualitative characteristics, and for analysis of specific class effects. The intercept for any specific class is $B_0 + b_1$ for class one, $B_0 + b_2$ for class two, etc. The intercepts for each occupation class are:

Class	Intercept Value
Professional	45.63
Administrative	46.29
Technical	54.35
Services	52.94
Clerical	46.07
Laborer	60.05
Housewife	60.39
Unemployed	48.83
Retired	66.94

Where:

$B_0 = 66.94$

Using the constant intercept value of 66.94 and the b values of the zero-one variables as deviations about the intercept, the intercept value for any set of socioeconomic characteristics may be estimated. That is, using the b value of -5.86 for sex and -14.27 for race, the following intercept values for sex and race are:

Sex \ Race	White	Nonwhite
Male	66.94	52.67
Female	61.08	46.81

Using the b values of occupation, the average intercept for all the zero-one variables may be accounted for. That is, if the household was headed by a white male with a professional occupation, the b value of -21.31 (professional) would be subtracted from 66.94 to give an intercept value of 45.63 recreation days per year. The effect of the rest of the variables upon this intercept may then be computed.

INTERPRETING THE CROSS-PRODUCT VARIABLES

The basic assumption for the continuous variables is that their effects are nonadditive. To test this assumption, family income, leisure time, and age were entered as cross-products.

When the "b" value is significant for two variables entered as a cross-product, there is an interrelationship indicating that the effect of one variable changes at different values of the other variable. The technique of using cross-products of two variables makes it possible to estimate the marginal effect of either variable, given a value of the other.

The relationship between age and income was significant. The results of this interrelationship indicated different effects from the income factor at different age levels. This marginal effect may be computed by taking a partial derivative with respect to income, and then substituting different ages into the equation. The same type of solution would yield the marginal effect of age at various income levels.

Income example: To estimate the net marginal income effect in terms of water-oriented outdoor recreation days, a partial derivation with respect to income is taken from the general model:

$$\frac{\partial X_1}{\partial X_2} = b_2 + B_{32}X_7$$

where:

b_2 = coefficient of income
b_{32} = coefficient of the cross-products
X_1 = annual recreation days
X_2 = annual family income
X_7 = age in years.

Entering the coefficients for the above model yields: net marginal recreation days with respect to income = $(-.001540) + (.000068)\ X_7$.

Using different age levels in the model, the net marginal income effect in recreation days for the various age levels is estimated. It is noted that as age increases, the marginal effect of income increases (table 2). Remember that the levels of all variables other than age and income are held constant.

Elasticity of demand may be computed for recreation in relation to the continuous variables:

$$E_j = \frac{\partial X_i}{\partial X_j} \cdot \frac{X_j}{X_i}$$

where:

j = any specific variable
X_1 = annual recreation days.

Letting X_j denote income, the elasticity of demand for recreation in relation to income is derived. Substiuting for the $\frac{\partial X_1}{\partial X_j}$ gives:

$$E_2 = (b_2 + b_{32}X_7) \cdot \frac{X_2}{X_1}$$

Inserting the mean values for the variables, the elasticity of demand at the mean is: $E_2 = 0.975$.

Table 2.--Marginal income effect of recreation demand at various age levels of the household head, St. Louis, Mo., metropolitan area

Age of household head	Net marginal recreation days per $1,000 income 1/
30 ---------	+ .50
40 ---------	+1.18
50 ---------	+1.86
60 ---------	+2.54
70 ---------	+3.22

1/ Change in number of recreation days per added $1,000 family income.

INTERPRETING THE QUADRATIC VARIABLES

Education, age, and family income were entered as squared terms, or quadratics, to test whether their influence on the dependent variable was curvilinear. Education and age were found to be significant. The marginal effect of education can be estimated as follows.

Education example: The net marginal effect of education can be estimated by taking the partial derivative with respect to education:

$$\frac{\partial X_1}{\partial X_4} = b_4 + 2b_{30}X_4$$

where:

b_4 = coefficient of education

b_{30} = coefficient of education squared $(X_4)^2$

X_1 = annual recreation days

X_4 = education in years completed.

Entering the coefficients for the above model gives the following results:

Net marginal recreation days with respect to education =

$$(-4.170880) + 2(.218604)\ X_4 = (-4.170880) + (.437208)\ X_4.$$

The marginal effect of education, with all other variables held constant, is negative up to approximately 10 years of school, and then becomes positive as the level increases. The net marginal effect of education on days of recreation is shown in table 3.

Table 3.--Marginal effect of education on days of recreation activity, St. Louis, Mo., metropolitan area

Years completed	Net marginal effect of education in recreation days
Elementary:	
4	-2.42
7	-1.11
8	- .67
High School:	
11	+ .64
12	+1.08
College:	
15	+2.39
16	+2.82
17	+3.26

APPLICATION OF THE PREDICTIVE MODEL

The model may be used to predict the annual number of days of water-oriented outdoor recreation for a typical family with specific socioeconomic characteristics. It may also be used for predictive purposes for a population of a metropolitan area by use of the mean values of the socioeconomic characteristics of the population, multiplied by the number of families in that population.

Example 1.--Computation of annual water-oriented outdoor recreation days of a family with specific socioeconomic characteristics:

X_2 = Annual family income--$15,000
X_4 = Education of household head--16 years
X_5 = Sex of household head--male
X_6 = Race of household head--white
X_7 = Age of household head--40 years
X_{10} = Occupation of household head--administrative.

Inserting the data into the general model, the number of annual water-oriented outdoor recreation days for this specific family may be estimated. The model is as follows:

$$X_1 = 66.937580 + -.001540 \cdot 15{,}000 + -4.170880 \cdot 16 + -5.859799 \cdot 0 + -14.272207 \cdot 0 + -.076362 \cdot 40 + -20.643547 \cdot 1 + -.007790 \cdot 40^2 + .218604 \cdot 16^2 + .000068 \cdot 15000 \cdot 40.$$

The variables X_5 and X_6 would enter as zero in the model and their coefficients would drop out. The values of X_5 and X_6 in this case are included in the constant term, 66.937580.

Completing the mathematical computations, the recreation days estimated for this specific family are 37.7 days per year.

Example 2.--Family characteristics:

X_2 = Annual family income--$2,500
X_4 = Education of household head--8 years
X_5 = Sex of household head--female
X_6 = Race of household head--negro
X_7 = Age of household head--20 years
X_{12} = Occupations of household head--services.

Inserting the data into the general model yields the following equation:

$$X_1 = 66.937580 + -.001540 \cdot 2{,}500 + -4.170880 \cdot 8 + -5.859799 \cdot 1 + -14.272207 \cdot 1 + -.076362 \cdot 20 + -.13.996154 \cdot 1 + -.007790 \cdot 20^2 + .218604 \cdot 8^2 + .000068 \cdot 2{,}500 \cdot 20.$$

Completing the mathematical computations, the recreation days estimated for this specific family are 7.3 days per year.

Example 3.--To estimate the average water-oriented outdoor recreation days for the average family, the mean values of the socioeconomic characteristics of the sample population may be inserted into the model:

Family Characteristics:

X_2 = annual family income--\$8,543.48
X_4 = education of household head--11.48
X_5 = sex of household head--.152
X_6 = race of household head--.099
X_7 = age of household head--48.270
X_9 = occupation--professional--.108
X_{10} = occupation--administrative--.144
X_{11} = occupation--technical--.080
X_{12} = occupation--services--.205
X_{13} = occupation--clerical--.074
X_{14} = occupation--laborer--.155
X_{15} = occupation--housewife--.064
X_{16} = occupation--unemployed--.011

Retired = 16 percent, and enters as zero; X_9 through X_{16} = 84 percent and enter as proportions in the general model.[4] The total occupation effect is the sum of each occupation coefficient times its proportion of the sample.

Inserting the above data into the general model, the average number of water-oriented outdoor recreation days per year for the average family is estimated to be 27.3 days. The data from the interview schedules give 27.0 days per family per year.

There are 570,392 households in St. Louis County and St. Louis (City). The number of households times annual rate of participation gives a total demand estimate of 15.4 million days of water-oriented outdoor recreation using the data directly from the survey schedules, and 15.6 million days using the model.

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[4] Percentages based on composition of sample population

CONCLUDING REMARKS

The above procedures estimate the influence of socioeconomic variables upon the demand for water-oriented outdoor recreation. The results obtained should make it possible to better estimate the potential use of facilities being planned for specific areas. However, there are many aspects of recreation demand that require further investigation.

The analysis presented is based on a static situation. The study was based on a sample survey made in one locality at one point in time, with consumers facing a specific supply of recreation opportunities. The interrelationships of demand and supply are believed to be quite significant. Continuing investigation is needed to determine the influence of available facilities upon participation and to assess the stability of the derived coefficients over time.

The activity of the individual is also expected to be influenced by his experiences. Skills in recreation activities, such as water skiing, power boating, and scuba diving, are not easily acquired. Facilities or knowledge of these activities were not available to many persons during their early years, and this lack of skills may make many reluctant to subsequently participate in them. There is a need for additional research into these and other factors influencing demands for outdoor recreation.

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APPENDIX

Sampling Procedure

The sample area consisted of St. Louis (City) and St. Louis County, Mo. The procedure used was to draw a three-stage cluster sample of 1,000 households 5/ at random from the area using census tracts as primary sampling units. Twenty-five tracts and 25 alternates were drawn, each primary tract having a definite alternate.

In the second stage of the sampling procedure, the census tracts were divided into segments. The first step was to list the census tracts in St. Louis (City) according to their respective number of households. Census data provided the number of households for each block in the city. These blocks were then grouped into segments of similar size according to number of households. For the St. Louis County portion, visual inspection of blocks and judgment estimates of housing units per block were made. This procedure was necessary since census data were not available on a block basis for the county. The segments were then outlined on a map according to similar numbers of households. Each segment in each tract was numbered. The number of interviews to be taken in each tract was proportional to the number of housing units in that tract. Using cluster sampling with 10 interviews per segment, the number of segments per tract was calculated. A table of random numbers was used to identify the sample segments for each tract. This procedure resulted in 100 segments of 10 interviews each being distributed on a weighted basis to the 25 census tracts.

For the third stage of the sampling procedure, all possible starting points in the segment were listed; that is, the block, the corner of the block, and the direction to begin were listed and numbered. The starting block in the segment, the corner of the block, and the direction to begin interviewing were determined by a table of random numbers.

The interviewers were instructed to get data from the head of the household, if possible. In some instances, however, the wife was interviewed. Each interview schedule was numbered with a specific code to permit identification as to census tract, segment, and respondent within the segment.

Interviewers were selected and hired in the St. Louis area, and were supervised by a University of Missouri employee. All interviewers attended a training school and made at least one interview accompanied by the supervisor.

5/ Equals 0.2 percent of total population.

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